Oceanographic Conditions in the Newfoundland Region during 1998

Background

The physical oceanographic environment influences the yield (growth, reproduction, survival), and behaviour (distribution catchability, availability) of marine organisms as well as the operations of the fishing industry. Changes in this environment may contribute directly to variations in resource yield, reproductive potential, catchability, year-class size (recruitment) and spawning biomass as well as influencing the perception of the resource status and the efficiency and profitability of the industry.

Physical oceanographic conditions (mainly water temperature and salinity) are therefore measured during research vessel resource surveys. Additional hydrographic, meteorological and sea ice data are obtained from a variety of sources, including standard monitoring stations, research studies, ships-of-opportunity, fishing vessels, and remote sensing (satellites).

All of the hydrographic data are edited and archived in Canada's national Marine Environmental Data Service (MEDS) database. A working copy is maintained in a zonal database at the Bedford Institute of Oceanography in Dartmouth and at the Northwest Atlantic Fisheries Center in St. John's.

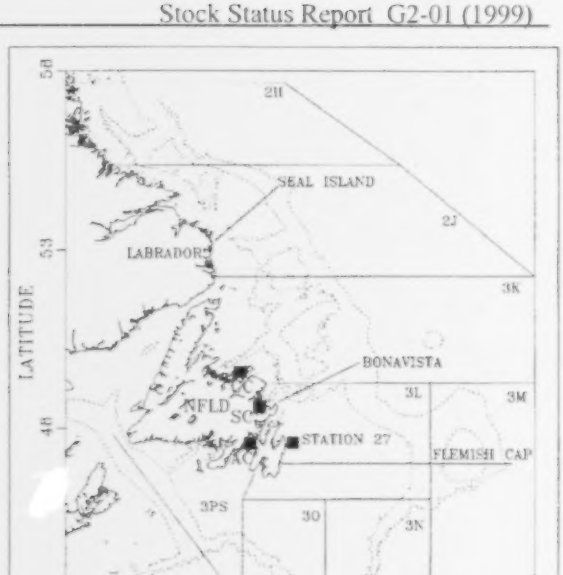

Fig. 1. Map of the Newfoundland Region showing the position of standard transects, long-term-temperature monitoring sites (CC, SC, AC) and Station 27. Depth contours are 300 and 1000 m.

Summary

- Average annual air temperatures and the Newfoundland Shelf ice extent was below normal during 1998. The ice duration was also shorter than the long-term average.
- During 1998 temperatures off St. John's at Station 27 ranged from 0.3° to 1°C above normal during winter and spring.
- By mid-summer a negative temperature anomaly developed in the upper water column with temperatures reaching 1° to 2°C below normal by late summer and early autumn.
- Bottom temperatures throughout the year at Station 27 were slightly above normal

- Upper layer salinities were below normal during the first half of the year, particularly during the summer months.
- The volume of sub-zero °C water on the Newfoundland and southern Labrador Shelf during 1998 was below normal, continuing a trend established in 1995.
- Bottom temperatures on the Grand Bank during the spring were up to 1°C above the long-term average and above average during the fall over many areas.
- On St. Pierre Bank bottom temperatures were near the long-term average during the spring of 1998.
- In general during 1998 temperatures continued above normal over many areas, particularly on the Grand Bank during spring and over the deeper portions of the Northeast Newfoundland Shelf.

INTRODUCTION

The ocean environment on the Newfoundland Shelf is influenced by the Labrador Current, cross-shelf exchange with warmer continental slope water and bottom topography. Superimposed are large seasonal and interannual variations in solar heat input, ice cover and storm forced mixing. The resulting water mass on the shelf is characterized by large annual cycles with strong horizontal and vertical temperature and salinity gradients. Water properties are monitored extensively by fisheries assessment and oceanographic research surveys throughout the year (Fig. 1). Some of these observations are expressed as differences from their mean or anomalies. The long-term means are standardized to a base period from 1961-1990 in accordance with the convention of the World Meteorological Organization.

Conditions in 1998

The annual mean air temperature at Cartwright on the Labrador Coast was above normal during 1998, an increase over 1997 values and above the long-term mean (Fig. 2). The air temperature time series since the 1960s show large variations, superimposed on a general downward trend up to the early 1990s. Recently, however air temperatures have been above normal. The time series of ice area on the Newfoundland and Southern Labrador Shelves show that the peak

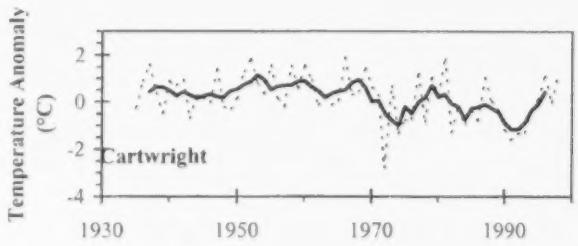

Fig. 2. Departures from normal mean air temperature (dashed line) and the 5 year means at Cartwright on the Labrador Coast.

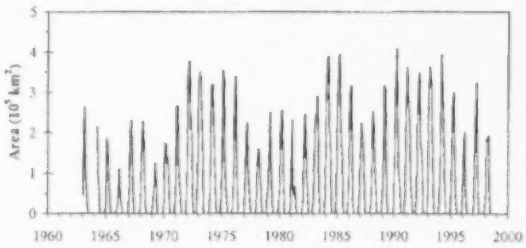

Fig. 3. Time series of ice areas off Newfoundland and southern Labrador.

extent of pack ice during 1998 decreased over 1997 values and was below the heavy ice years of the early 1990s (Fig. 3).

Station 27 Temperature and Salinity

The temperature time series at Station 27 (Fig. 1) located in the inshore branch of the Labrador

Current, shows upper layer temperatures near constant at about 0°C from January to early April and from –1° to –1.5°C throughout the year near the bottom at about 175-m depth. By early May the upper layer temperature had warmed to 2°C and to above 12°C by August at the surface, after which the fall cooling commenced. These temperatures ranged from 0.3° to 0.5°C above normal for the winter months over most of the water column. By mid-Summer temperatures

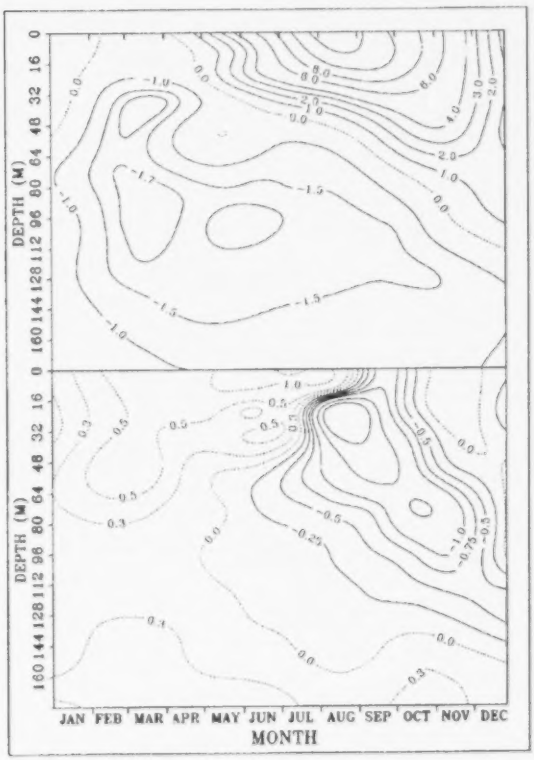

Fig. 4. Monthly temperature (top) and their departures from normal (bottom) at Station 27 as a function of depth for 1998.

fell below normal by up to 2°C at 30-m depth. These colder than normal temperatures penetrated deeper into the water column reaching 100 m depth by November. Fall temperatures in the upper layer were about normal. Bottom temperatures throughout the year were above normal by about 0.3°C (Fig. 4). Upper layer salinities (Fig. 5) reached a maximum of 32.2 in mid March and decreased to a minimum of 31.1

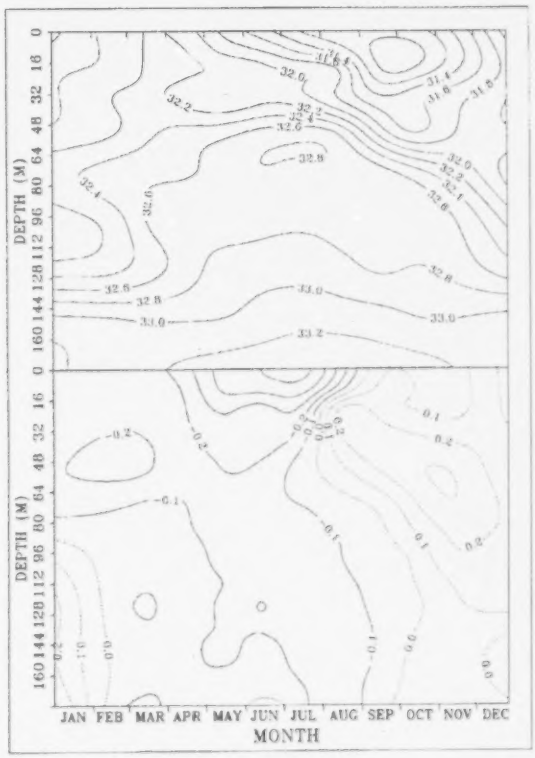

Fig. 5. Monthly salinity (top) and their departures from normal (bottom) at Station 27 as a function of depth for 1998.

by late August, these values were slightly below the long term mean. In deeper water, salinities generally ranged from 32.4 to 32.8, except for a positive anomaly (up to 0.3) centered at about 50-m depth during fall, these values were generally near normal throughout the year.

The station 27 depth averaged annual temperature (which is proportional to the heat content of the water column) time series (Fig. 6) shows large fluctuations at near decadal time scales, with cold periods during the early 1970s, mid 1980s and early 1990s. During the time

period from 1950 to the late 1960s the heat content of the water column was generally above the long-term mean. Recently the heat content of the water column varied from a record low in 1991, to a near record high during 1996 and was near the long-term mean in 1998. The upper water column (0 to 50 m) depth averaged summer (July-September) salinitiy anomalies (Fig. 6) shows similar behaviour as the heat content time series but with longer, less saltier than normal periods corresponding to the colder than normal conditions. During 1993 summer salinities started returning to more normal values but decreased again by the summer of 1995 to near record lows but increased again in 1996 and were near normal in 1998.

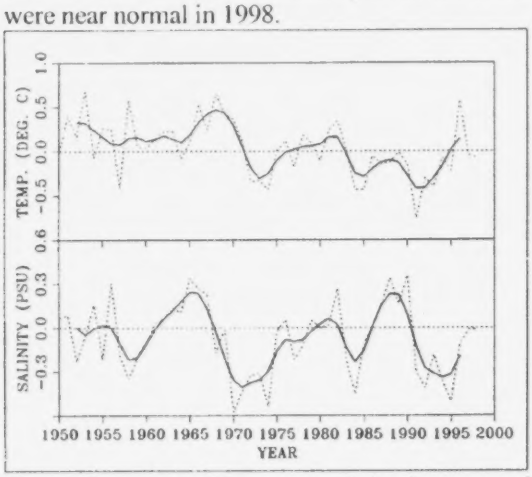

Fig. 6. Departures from normal depth averaged (0-176 m) Station 27 temperature and upper layer (0 to 50 m) averaged summer (July-Sept) salinity. The heavy lines are the three-year running means or averages.

St. Pierre Bank (Division 3Ps)

The time series of temperature anomalies from 19[illegible] to 1999 on St. Pierre Bank within 100-m depth are shown in Fig. 7 at standard depths of 0, 20, 50 and 75 m. This record was smoothed to suppress the monthly variations, which are

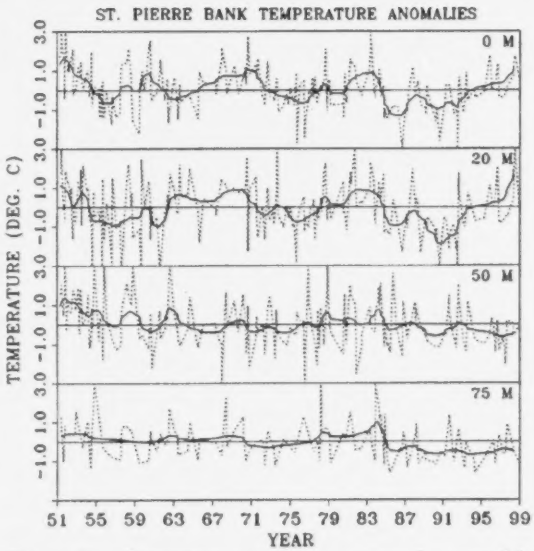

Fig. 7. Departures from normal monthly temperature at standard depths on St. Pierre Bank in subdivision 3Ps. The heavy line represents the long-term trends.

also shown as the dashed lines in the figure. The temperature trends are characterized by large variations greater than 1°C above and below normal with periods between 5 to 10 years. During the cold period beginning around 1984 temperatures decreased by up to 2°C in the upper water column and by 1°C in the lower water column and continued below normal until about 1990. Since 1991 temperatures have warmed over the top 50-m of the water column but have remained well below average at 75-m depth. During 1992 to 1996 the temperature varied above and below normal in the top 20-m of the water column, but remained mostly below normal near bottom. During 1996 to 1998 temperatures were mostly above normal in the upper layer and appear to be moderating in the lower layer.

Inshore Temperature Time Series

Temperature time series from monitoring sites at Comfort Cove in Notre Dame Bay, Stock Cove

in Bonavista Bay and at Arnold's Cove Placentia Bay (Fig. 1) at 10-m depth for the time period 1990 to 1999 are displayed in Fig. 8. Temperatures were up to 4° to 6°C below normal during 1991 and 1993 in the

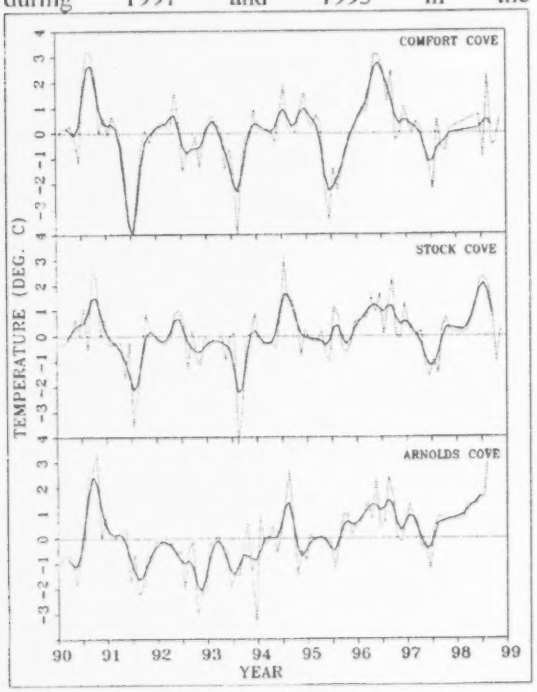

Fig. 8. Departures from normal monthly temperatures at 10 m depth for Comfort Cove (CC in Fig. 1), Notre Dame Bay, Stock Cove (SC), Bonavista Bay and for Arnold's Cove (AC), Placentia Bay.

summer months in Notre Dame and Bonavista Bays and up to 2°C below normal in Placentia Bay. During 1994 temperatures were from 1° to 3°C above normal during the summer months and from 1° to 3°C above normal throughout most of 1996 at all 3 sites. By mid 1997 temperatures were below normal at all three sites but recovered to near normal values late in 1997. These above normal values continued during most of 1998.

THE NF SHELF COLD INTERMEDIATE LAYER (CIL)

As is well known, the temperature structure on the Newfoundland Continental Shelf is dominated by a layer of cold sub-zero °C water, commonly referred to as the Cold Intermediate Layer or CIL, trapped between the seasonally heated surface layer and warmer continental

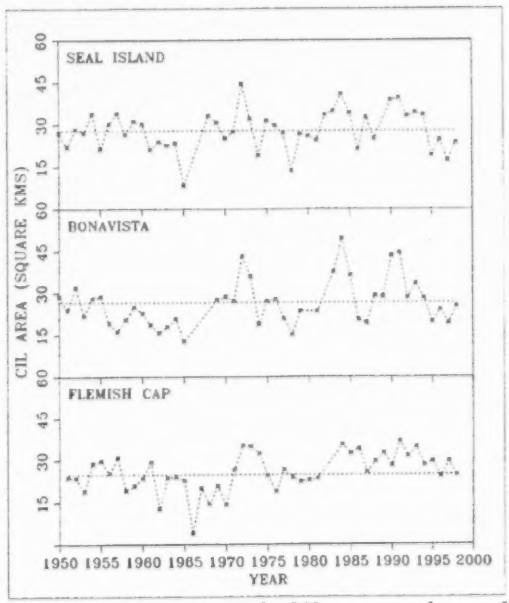

Fig.9. Time series of CIL area along the standard transects across the Newfoundland Shelf shown in Fig. 1.

slope water near the bottom. Along the Bonavista transect during the summer of 1998 this cold layer extended offshore to about 220 km, with a maximum thickness of about 220 m corresponding to a cross-sectional area of about 25 km^2, compared to the 1961-90 average of 27 km^2. Figure 9 shows the time series of the CIL area for the Seal Island, Bonavista and Flemish Cap transects, the positions of which are shown in Fig. 1. Low values of CIL areas correspond to warm oceanographic conditions. During the summer of 1998 the CIL area off Bonavista was about 5% below normal compared to 28% below

normal in 1997 and 10% below normal in 1996. The CIL area along the Seal Island transect was also below normal by about 15% during 1998, 38% in 1997 and 12% during 1996. During the cold years from 1990 to 1994 the CIL was above normal reaching a peak of more than 60% in 1991. On the Grand Bank along the Flemish Cap transect the CIL was normal compared to 20% above normal in 1997. In general, during 1998 the total amount of sub-zero °C water on the Newfoundland Shelf is continuing a below normal trend established in 1995.

BOTTOM TEMPERATURES

The 1998 and the 1961-1990 average fall bottom temperature maps for the 2J3KLNO areas are shown in Figs. 10 and 11 (temperature contours are -1, -0.5, 0, 1, 2, 3 and 3.5°C, depth contours are 300 and 1000 m). The average bottom temperature over most of the Northeast Newfoundland shelf (2J3K) ranges from less than 0°C inshore, to above 3°C offshore at the edge of the continental shelf. The average temperature over most of the Grand Bank varies from -0.5°C to 0°C over the central and northern areas, 0° to 3 °C over south-eastern regions and to above 3°C at the edge of the continental shelf. In general, bottom temperatures are nearly uniform at constant depth over most of the Northeast Newfoundland Shelf. The percentage area of water less than -0.5°C over the Grand Bank and Northeast Shelf from 1990 to 1994 was much larger than the 1961-1990 average. In 1992 and 1993 the bottom temperatures ranged from 0.25°C to 0.75°C below normal over most of the Northeast Newfoundland Shelf and from 0.25°C to 1°C below normal over the Grand Bank. During the fall of 1996 bottom temperatures warmed over most areas on the Newfoundland Shelf reaching 0.5°C above normal in many places. During 1996 the percentage area of water less than -0.5 °C on the Grand Bank was below average with a complete absence of sub-zero °C water on the Northeast Newfoundland Shelf from the Northern Grand

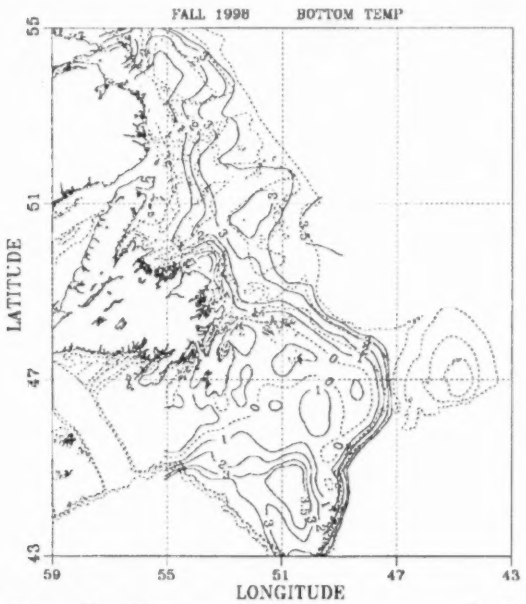

Fig. 10. Bottom temperature map of the Newfoundland Shelf Region for the fall of 1998.

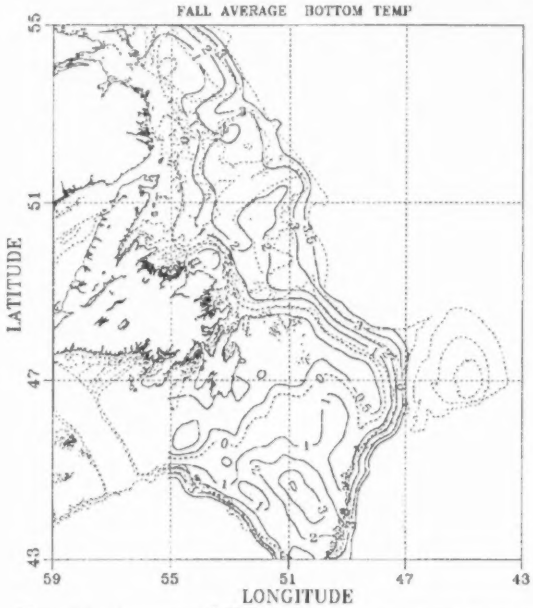

Fig. 11. Average fall bottom temperature map of the Newfoundland Shelf Region.

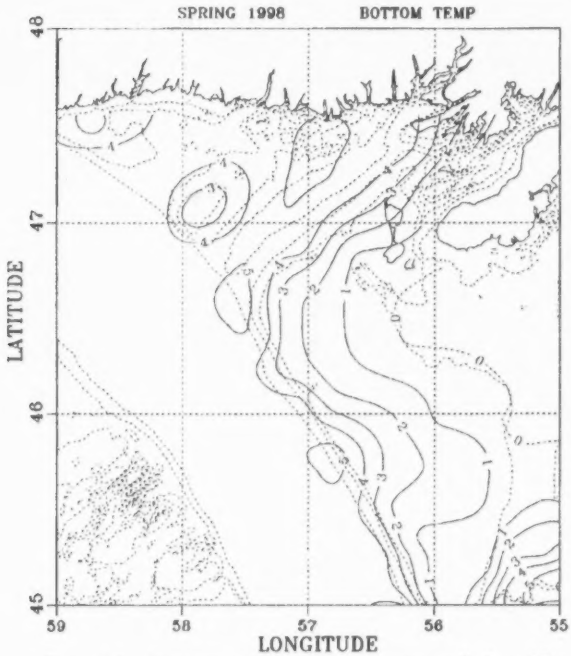

Fig. 12. Bottom temperature map of the 3Ps region during spring of 1998.

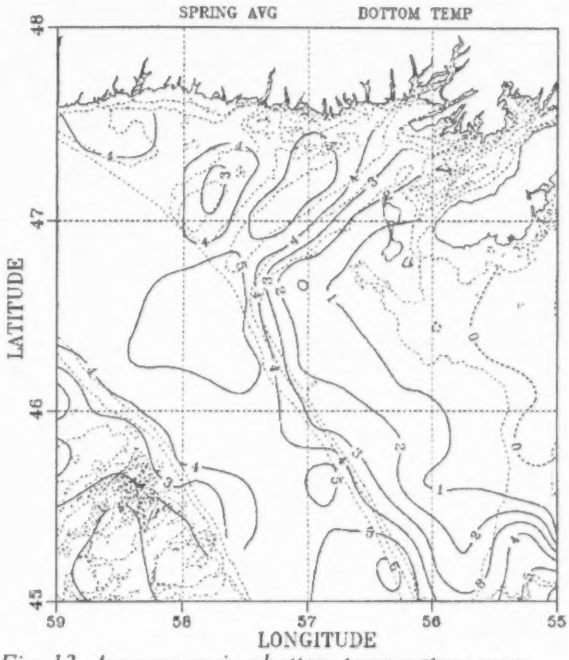

Fig. 13. Average spring bottom temperature map of the 3Ps region.

Bank to Nain Bank. Bottom temperatures on the Grand Bank during the spring of 1998 were up to 1°C above the long-term average with a very small area of sub-zero °C values restricted to the deeper portions of the Avalon Channel. During the fall of 1998 bottom temperatures were above normal over many areas, particularly on the offshore portion of the Northeast Newfoundland Shelf (Fig. 10). An analysis of the areal extent of bottom water in different temperature bins reveals a significant decrease in the areal extent of subzero °C water and a corresponding increase of about 70% in the extent of water above 1°C during the spring of 1998 compared to 1997 (Fig. 14).

The April 1998 and the April 1961-90 average bottom temperature maps for the 3Ps and 3Pn areas are shown in Figs. 12 and 13. In general, bottom temperatures are nearly uniform at constant depth around the Laurentian Channel and the Southwestern Grand Bank increasing from 2°C at 200-m depth to 5°C in the deeper water. The average bottom temperature during April ranges from 5°C in the Laurentian, Burgeo and Hermitage Channels to about 3°C to 4°C on Rose Blanche Bank and on Burgeo Bank and from 0°C on the eastern side of St. Pierre Bank to 2° to 3°C on the western side. During April 1998 temperatures were about average over Burgeo Bank and Hermitage Channel and appear to have moderated to near normal values over most of St. Pierre Bank where temperatures ranged from 0.5° to 3°C (Fig. 12). This represents an increase from 1997 values. The areal extent of bottom water with temperatures above 1°C was about 50% of the total area of the banks in the 3Ps region during 1998 the first significant amount since 1984 (Fig. 15). In general, temperature conditions in this region are highly variable (Fig. 7) but it appears that the cold trend on St. Pierre Bank is moderating during 1998.

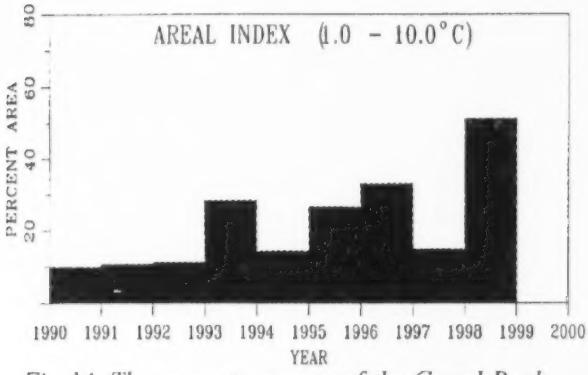

Fig 14. The percentage area of the Grand Bank covered by water with bottom temperatures greater than 1°C during spring.

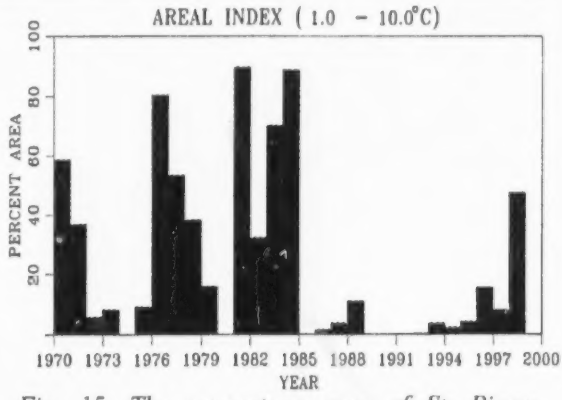

Fig. 15. The percentage area of St. Pierre, Burgeo and Green Banks covered by water with bottom temperatures greater than 1°C.

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